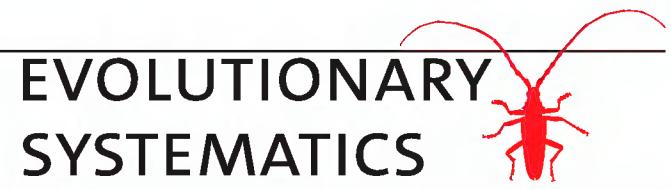
Evolutionary Systematics. 8 2024, 273–278 | DOI 10.3897/evolsyst.8.129984



Reidentification of a 19th century specimen reveals the first record of *Amphisbaena hogei* Vanzolini, 1950 (Squamata, Amphisbaenidae) in Minas Gerais, Brazil

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Academic editor: Claudia Koch ♦ **Received** 18 June 2024 ♦ **Accepted** 20 November 2024 ♦ **Published** 4 December 2024

Abstract

For almost 60 years, a specimen of *Amphisbaena* collected in the 19th century by the Danish zoologist Johannes Theodor Reinhardt in southeastern Brazil has been identified as *Amphisbaena prunicolor*. Here I present a reidentification of this specimen (NHMD R4448) as *A. hogei*, together with a review of known records of this small worm lizard species, endemic to Brazilian Atlantic Forest. This represents the first record of *A. hogei* for the state of Minas Gerais. Most known records of *A. hogei* are based on specimens collected more than half a century ago and urbanization could have led to local extinction in some localities, triggering an alert regarding its conservation status.

Key Words

Amphisbaenia, collection, natural history museum, naturalists, worm lizard

In his taxonomic review of *Amphisbaena* species of the *darwinii* group, Gans (1966a) cites a specimen he identified as *A. prunicolor* (Cope, 1885) from Juiz de Fora, Minas Gerais, Brazil. This specimen is housed at the Universitetets Zoologiske Museum, now the Natural History Museum of Denmark (KM R4448, currently NHMD R4448) (Figs 1, 2). Another specimen identified as *A. prunicolor* by Gans (1966a), from "São Cyprião", Minas Gerais, is at the Museum of Comparative Zoology, Harvard (MCZ 5124). These records, though not unique, differ from the general geographic distribution pattern of *A. prunicolor*, which is primarily found in southern Brazil, the southeastern edge of Paraguay, and in Misiones, Argentina (Perez et al. 2012; Perez and Borges-Martins 2019).

A reanalysis of the MCZ 5124 specimen indicated it is *Amphisbaena metallurga* Costa et al., 2015 (Costa 2022). Additionally, the collection location was corrected to the area of the current municipality of Alvorada de Minas, Minas Gerais (Costa 2022). A reexamination of the specimen from Juiz de Fora, however, is needed. This specimen was collected by Johannes Reinhardt, and although there is no clear information on the date of collection, its museum entry dates to February 6, 1849 (email from Daniel Klingberg Johansson, NHMD collection manager, on April 29, 2019).

Johannes Theodor Reinhardt (1816–1882), born in Denmark, visited Brazil on three occasions (Adler 1989). Between 1845 and 1847, he was one of the zoologists aboard the corvette Galathea, sent by the King of Denmark for scientific investigations (Papavero 1973; Adler 1989). He returned to Brazil in 1850–1852 and 1854–1856, conducting scientific collections, especially in the Lagoa Santa region (Reinhardt and Lütken 1862; Papavero 1973; Adler 1989).

Since the NHMD R4448 specimen's entry into the museum collection dates to February 1849, it would have been collected by Reinhardt during his first trip to Brazil. After the Galathea docked in Rio de Janeiro in May 1847, Reinhardt left the expedition and traveled to Lagoa Santa, Minas Gerais, to meet his compatriot Peter Lund (Bille 1851; Papavero 1973). On the way to Lagoa Santa, Reinhardt passed through Juiz de Fora, where it is known he collected bird specimens on June 21, 1847 (Pinto 1955;

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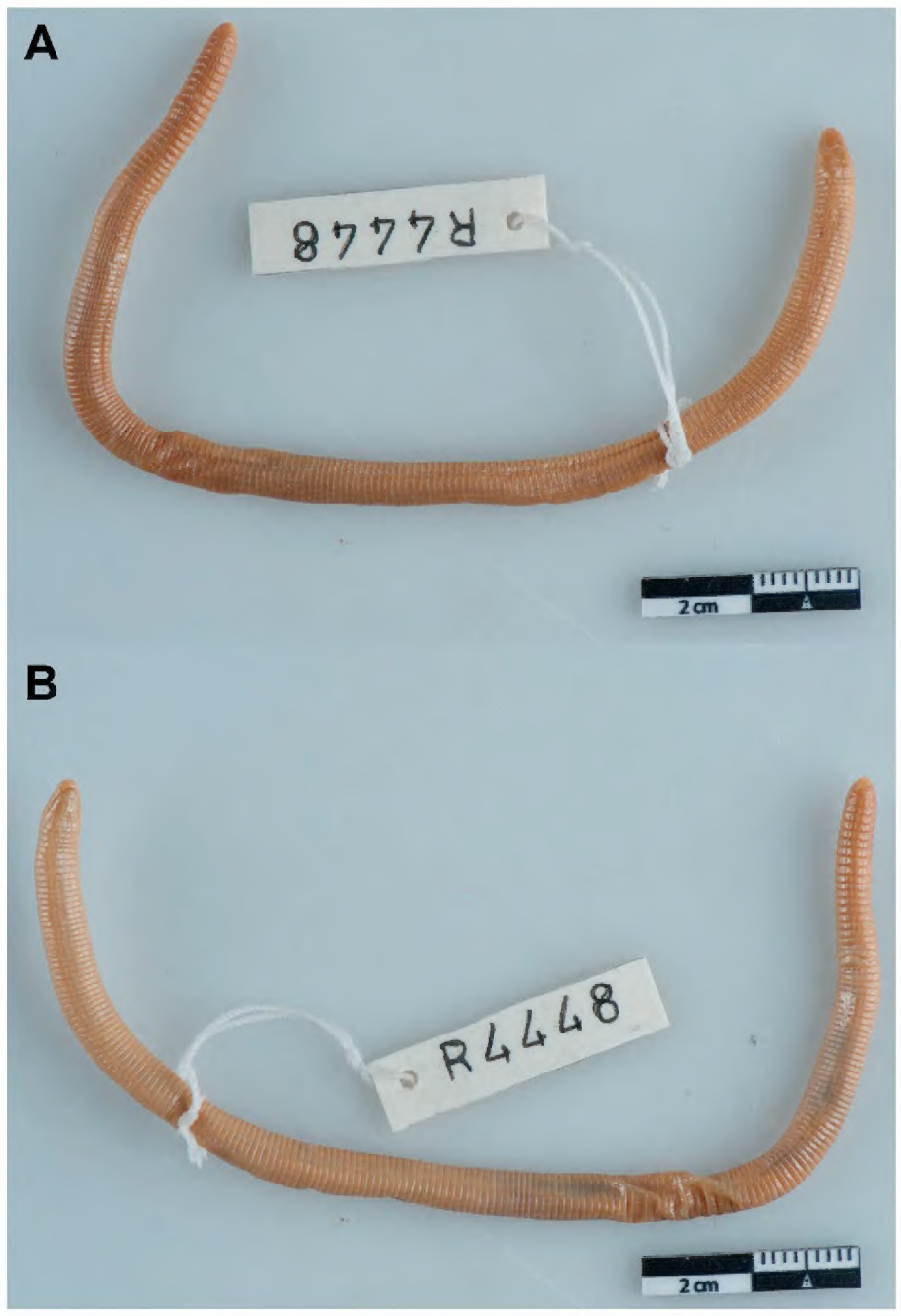

Figure 1. Dorsal (**A**) and ventral (**B**) view of specimen NHMD R4448, from Juiz de Fora, Minas Gerais, Brazil. Photo: Daniel Klingberg Johansson.

Krabbe 2007). It was probably on this occasion that NHMD R4448 was collected.

The specimen NHMD R4448 was first identified as *Amphisbaena vermicularis* Wagler, 1824 in the museum catalogue until Carl Gans reidentified it as *A. prunicolor* (e-mail from Daniel Klingberg Johansson, 2019). In Reinhardt's classic work published with Christian Frederik Lütken on Brazilian amphibians and reptiles (Reinhardt and Lütken 1862), *A. vermicularis* is mentioned, and the authors state that Reinhardt collected a "considerable number" of specimens of this species in Minas Gerais, particularly in Lagoa Santa. Indeed, there are 18 specimens in the NHMD from Lagoa Santa identified as *A. vermicularis* (Gans & Amdur, 1966), a species widespread in Brazil's open vegetation areas (Guedes et al. 2020).

The ring (annuli) counts cited for *A. vermicularis* by Reinhardt and Lütken (1862) (216 to 233 body annuli and 28 to 29 tail annuli) suggest that NHMD R4448 was not considered by those authors, as it has 183 body annuli and 20 tail annuli (Gans 1966a), or the counts were made erroneously. It is worth noting that the only specimens explicitly mentioned by Reinhardt and Lütken (1862) as coming from Juiz de Fora are two anuran species described in their work: *Cystignathus discolor* (= *Thoropa miliaris* (Spix, 1824)) and *Leiuperus verrucosus* (= *Ischnocnema verrucosa*).

Unlike Lagoa Santa, located in the Cerrado ecoregion (Tropical & Subtropical Grasslands, Savannas & Shrublands biome), Juiz de Fora is covered by the Atlantic Forest (Tropical & Subtropical Moist Broadleaf Forests biome) (Dinerstein et al. 2017). *Leposternon microcephalus* Wagler, 1824 is the most common amphisbaenian in the region, while *Amphisbaena alba* Linnaeus, 1758 is rarely recorded (Sousa et al. 2012). Could there be a cataloging error for the NHMD R4448 specimen? This hypothesis cannot be ruled out, but neither can the possibility that it belongs to a locally rare species, as other reptile species seem to be or have become rare in Juiz de Fora in recent decades (Sousa et al. 2012). But is NHMD R4448 really an individual of *A. prunicolor*?

The specimen in question has the following characteristics: 183 body annuli, three lateral annuli, 20 tail annuli, autotomy on the 8th tail annulus, 12 dorsal segments and 16 ventral segments at a mid-body annulus, three supralabials, one post-supralabial, three infralabials, one post-ocular, one temporal, a row of two post-genials, a row of six post-malars, four sequentially arranged pre-cloacal pores, six pre-cloacal scales, 13 post-cloacal scales, 113 mm snout-vent length (SVL) and 16 mm tail length. These characteristics quickly separate the specimen from all *Amphisbaena* species except *A. hogei* Vanzolini, 1950 and *A. prunicolor*, and align closely with *A. metallurga*.

About 10% of known *A. metallurga* specimens have four pre-cloacal pores (most have two), and the modal number of ventral segments is 14. The presence of 183 body annuli and 20 tail annuli would be a new lower limit for the species, whose known range is 185–199 body annuli and 23–25 tail annuli (Costa et al. 2019b; Costa 2022). Additionally, the species is known from mountainous areas at the eastern limit of the Atlantic Forest, in contact with the Cerrado, about 240 km north from Juiz de Fora (Costa et al. 2019b; Costa 2022).

Amphisbaena prunicolor, as previously mentioned, has a more southern geographic distribution. Specimens tend to be brown-purple in color, but this can fade in very old specimens (Perez et al. 2012). On the other hand, *A. hogei*'s typical color is light brown dorsally (Gans 1966a). Beyond this color difference, Perez et al. (2012) state that the two species are mainly distinguished by the number of tail annuli: 18–27 in *A. prunicolor* and 15–19 in *A. hogei*. However, one *A. hogei* specimen I examined at the Museu de História Natural Capão da Imbuia (MHNCI 7510), collected in Maricá, Rio de Janeiro, has 20 tail annuli, like NHMD R4448. The raw data from Perez et al. (2012) are not available but analyzing the raw data of 72 *A. prunicolor* specimens with intact tails identified by Gans (1966a), 51 specimens have 21 or more (mainly 22) tail annuli.

One overlooked characteristic is size. Adult *A. prunicolor* individuals average 178 mm SVL (141–238 mm in a sample of 110 adults) (Perez et al. 2012), while the largest *A. hogei* specimen measures 176 mm SVL (Gans 1966a). This does not rule out the possibility that NHMD R4448 could be a young *A. prunicolor*. However, the geographic distribution pattern of *A. hogei* would align more closely with the NHMD R4448 record than *A. prunicolor* (excluding other questionable records in southeastern Brazil) (Perez et al. 2012).

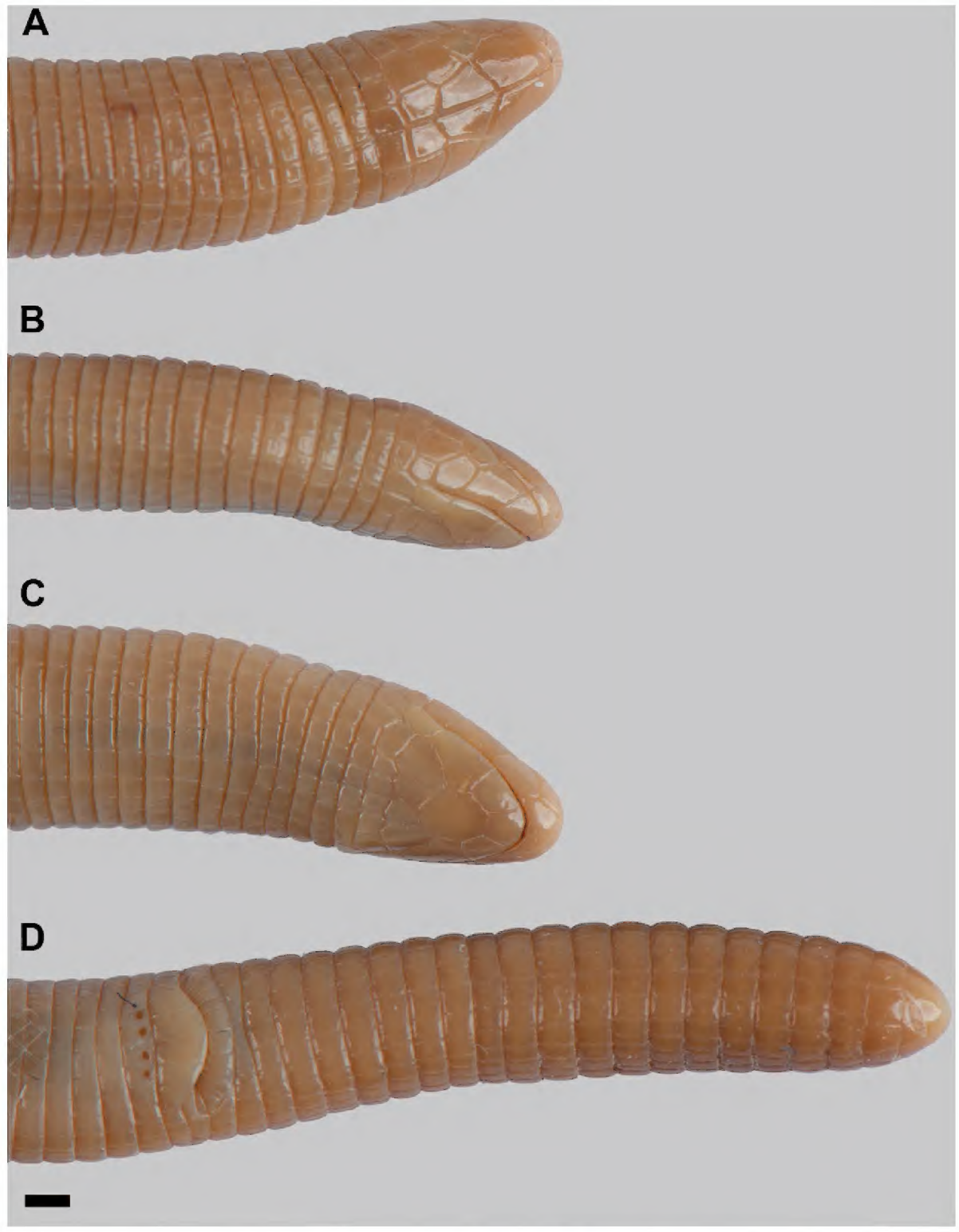

Figure 2. Detail of the head (dorsal (**A**), right lateral (**B**) and ventral (**C**) views) and cloacal region (**D**) of specimen NHMD R4448, from Juiz de Fora, Minas Gerais, Brazil. Photo: Daniel Klingberg Johansson. Scale bar: 1 mm.

Without coloration information, morphological differentiation between *A. hogei* and *A. prunicolor* can be challenging. Amphisbaenians are highly adapted to the subterranean environment, and their morphology tends to be very conserved, with some species, especially closely related ones, being very similar morphologically, like *A. miringoera* and *A. mitchelli* (Almeida et al. 2016), or even practically indistinguishable, like *A. anaemariae* and *A. mebengokre* (Ribeiro et al. 2019) or *Blanus cinereus* and *B. vandellii* (Cería-co and Bauer 2018). However, based on the available data, I consider it more plausible that the NHMD R4448 specimen is identifiable as *A. hogei* rather than *A. prunicolor*. A summary of main morphological characters useful in differentiating *A. hogei* from other four-pored amphisbaenian species in Minas Gerais, plus *A. prunicolor* is present at Table 1.

An updated map of *A. hogei* known occurrences, based on specimens examined by me and on literature records is here presented (Fig. 3, Table 2). A record in the database of Colli et al. (2016) from Ilha do Governador, state of Rio de Janeiro, is not considered here because of the lack of voucher information and the source marked as "*Vanzolini, ? - REVER*" ("Vanzolini, ? – review"). A recent list of reptiles from the state of Rio de Janeiro cites *A. darwinii* but not *A. hogei* (Oliveira et al. 2020). Although based on specimens deposited in collections (Oliveira et al. 2020) vouchers are not cited. Strauch (1881) cites two specimens of *A. darwinii* from Rio de Janeiro examined by him but not elsewhere, deposited at the Zoological Institute of Russian Academy of Sciences (ZISP 2743 and 2744). As their number of body annuli (204 and 205) is outside the known range of *A. hogei* and they were not examined by me even from photographs, they are not considered here.

Based on a single specimen housed at the Museu Nacional, Universidade Federal do Rio de Janeiro (MNRJ 18293) Rocha et al. (2023) described "*Amphisbaena carioca*", a *nomen nudum* (unavailable name) (H. C. Costa, in preparation). They argue this specimen differs from *A. hogei* by having very large parietals, a tail compressed after the base and lacking autotomy site (Rocha et al. 2023). What Rocha et al. (2023) call "very large parietals" seems to be the result of the fusion of the parietal of each side with an adjacent segment, "which gives the impression of laterally widened parietals" as stated by Gans (1966a) about *A. trachura* Cope, 1885. In fact, irregularities in the parietal region are common in some amphisbaenian species (Gans 1966a; Gans and Amdur 1966). Furthermore, contrary to what Rocha et al. (2023) claim, the tail of *A. hogei* "shows a gradual reduction in height" (Gans

Table 1. Morphological characters useful for distinguishing *Amphisbaena hogei* from four-pored *Amphisbaena* from Minas Gerais, Brazil, and from *A. prunicolor*. BA = body annuli; CA = caudal annuli; AA = autotomic annulus; DS = dorsal segments (modal value in parentheses); VS = ventral segments (modal value in parentheses); SL = supralabials; IL = infralabials; PP = precloacal pores (modal value in parentheses). Max. SVL = maximum recorded snout-vent length; REF = References: 1 (this study), 2 (Vanzolini 1950), 3 (Gans 1966a), 4 (Perez et al. 2012), 5 (Gans 1962), 6 (Hoogmoed 1973), 7 (Almeida et al. 2006), 8 (Gans 1966b), 9 (Ribeiro et al. 2007), 10 (Silveira et al. 2012), 11 (Assis et al. 2022), 12 (Costa et al. 2019b), 13 (Costa 2022), 14 (Perez and Borges-Martins 2019), 15 (Costa et al. 2019a), 16 (Gans and Amdur 1966).

Species	BA	CA	AA	DS	VS	SL	IL	PP	Max. SVL	REF
A. hogei	177–191	15–20	4–8	10–13 (10)	14–18 (16)	3	3	4	134 mm	1, 2, 3, 4
A. alba	198–248	13–21	no	30–42 (36)	35–46 (38, 40)	3–4 (4)	3	4–12	820 mm	5, 6, 7
A. mertensii	210–250	25–32	5–8	14–26 (18, 22)	16–25 (22)	3–4 (3)	3–4 (3)	4–8 (6)	458 mm	8, 9, 10, 11
A. metallurga	185–199	23–25	7–9	12–14 (12)	14–16 (14)	3	3	0–4 (2)	179 mm	12, 13
A. prunicolor	181–215	18–27	7–11	10–17 (13–14)	14–20 (16)	3	3	0 (♀), 4 (♂)	238 mm	3, 4, 14
A. talisiae	205–234	17–29	6–8	10–14 (12)	14–18 (14)	3	3	4	146 mm	15
A. vermicularis	214–260	23–35	4–8	17–26 (22)	18–27 (22)	4	3	4	327 mm	16

Table 2. Known records of *Amphisbaena hogei*. All in Brazil. Coordinate precision in decreasing order: local > proximate > (municipality) seat. Collection abbreviations follow Sabaj (2020), except for MTR (Miguel Trefaut Rodrigues, field number). MG: Minas Gerais; RJ: Rio de Janeiro; SC: Santa Catarina; SP: São Paulo.

State	Município	Locality	Latitude, Longitude	Source	Coordinate precision	voucher	OBS
MG	Juiz de Fora		-21.7639, -43.3500	(Gans 1966a)	seat	NHMD R4448	former KM R4448
RJ	Maricá		-22.9189, -42.8189	this study	seat	MHNCI 7510	
RJ	Rio de Janeiro	Restinga de Grumari	-23.0833, -43.5300	(Rocha et al. 2023)	local	MNRJ 18293	holotype of "*Amphisbaena carioca*" (*nomen nudum*)
SC	Joinville		-26.3039, -48.8458	(Gans 1966a)	seat	NMW 12337:6	
SP	Boituva		-23.2828, -47.6719	(Gans 1966a)	seat	MZUSP 6605	former DZ
SP	Caucaia do Alto		-23.6847, -47.0269	(Teixeira Jr et al. 2014, Costa et al. 2015; Dal Vechio et al. 2018)	seat	MTR 15328	
SP	Iguape	Estação Ecológica Juréia-Itatins	-24.439, -47.119	(Marques and Sazima 2004)	proximate	not collected	preyed by *Micrurus corallinus*
SP	Itanhaém	Ilha da Queimada Grande	-24.4917, -46.6786	(Gans 1966a)	local	SMF 57908, 57909, 57910	
SP	Itanhaém	Ilha dos Alcatrazes	-24.1025, -45.6947	(Vanzolini 1950; Gans 1966a)	local	MZUSP 1893, 1894, 6502–6512, 6692, 6905–6920, SMF 57904–57907	Type locality of *Amphisbaena darwinii hogei* (holotype: MZUSP 6905, former IBSP 1070a).
SP	Itapeva		-23.9819, -48.8758	(Gans 1966a)	seat	MZUSP 3311	former DZ
SP	Ribeirão Grande	Fazenda Intermontes	-24.1981, -48.4241	(Costa et al. 2018)	proximate	ZUEC 3052	
SP	São Bernardo do Campo		-23.6939, -46.5650	(Gans 1966a)	seat	MZUSP 6545	former DZ
SP	São Paulo		-23.5460, -46.6290	(Gans 1966a; Barbo 2008; Marques et al. 2009)	seat	MZUSP 6633, 6634, 6675, 6691, 17003	
SP	Sete Barras	Parque Estadual Intervales	-24.2375, -48.0958	(Costa et al. 2018)	proximate	ZUEC 2507	
SP		Serra da Bocaina	-22.9400, -44.6600	(Dal Vechio et al. 2018; Teixeira Junior et al. 2019)	proximate	MTR 23383	

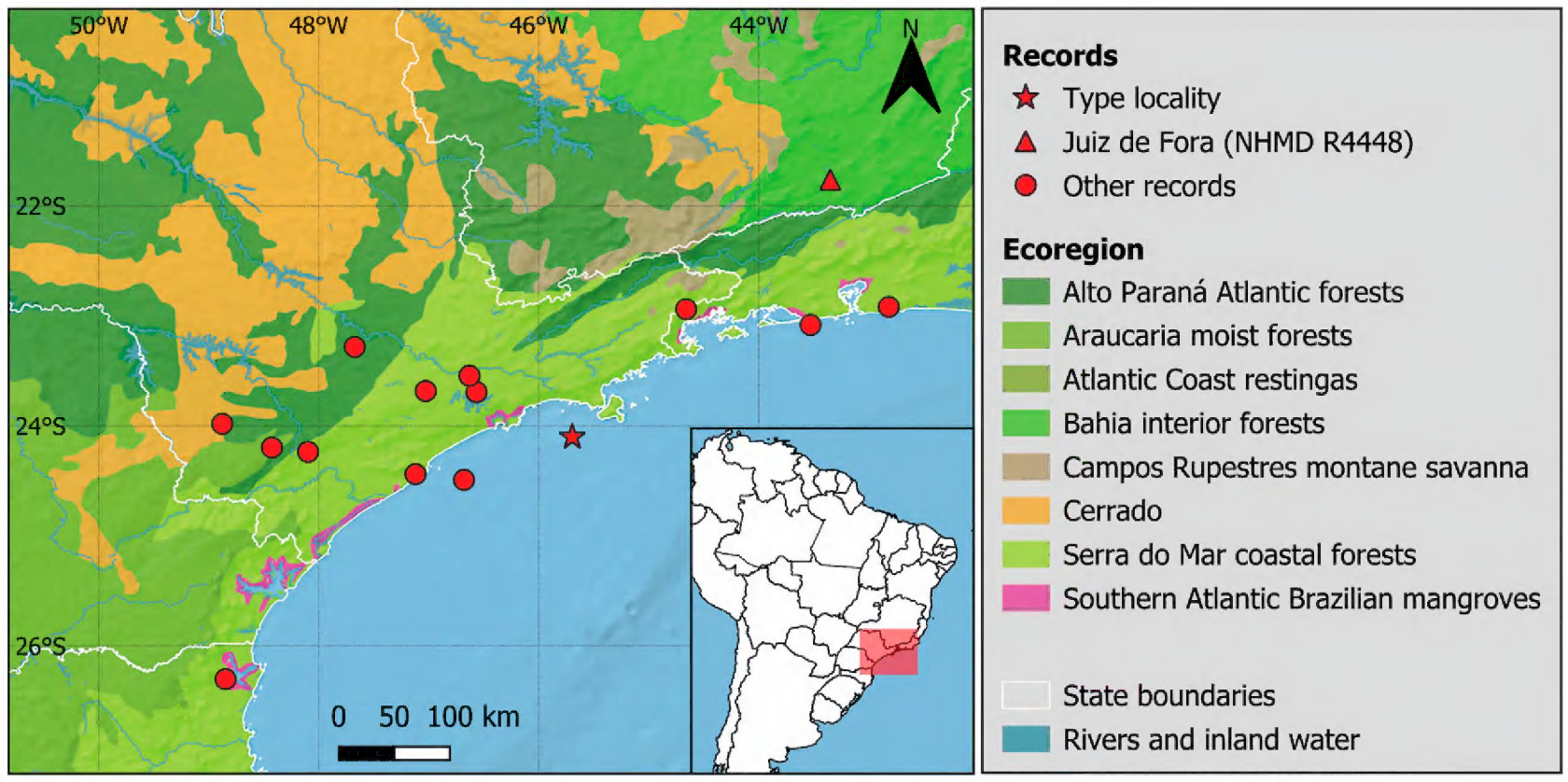

Figure 3. Geographic representation of known records of *Amphisbaena hogei*. For records information, see Table 2.

1966a, H. C. personal observation). Finally, information regarding autotomy constriction in *A. hogei* is contradictory in Gans' (1966a) text, as he writes "a clearly marked autotomy constriction" (p. 250) and "The autotomy annulus is narrowed [. . .]; There is no autotomy constriction of the tail." (p. 251) (Gans 1966a). The autotomy constriction is sometimes not clearly visible in species with autotomy (Gans 1964), but in the case of MNRJ 18293 it seems, based on Fig. 2 in Rocha et al. (2023) that the 8th annulus is autotomic. However, the specimen is desiccated, making the examination of this characteristic difficult and may even have increased the perception of tail compression and an apparent absence of autotomy. Having said that, I here consider MNRJ 18293 a specimen of *A. hogei*.

Amphisbaena hogei is known from Joinville (Santa Catarina) in the south, to Itapeva (São Paulo) in the west, Maricá (Rio de Janeiro) in the east, and Juiz de Fora in the north. It is essentially an Atlantic Forest species, inhabiting mainly the Serra do Mar coastal forests ecoregion, but also recorded in Alto Paraná Atlantic forests and its ecotone with the Cerrado and the Araucaria moist forests. The record in Juiz de Fora is the first in the Bahia interior forests ecoregion (Fig. 3), an area with a more seasonal climate and semideciduous forests (Sousa et al. 2012).

Despite its relatively wide distribution, most records of *A. hogei* are based on specimens collected decades ago (Gans 1966a). Moreover, the species may have disappeared from some localities such as the city of São Paulo due to urbanization (Barbo and Sawaya 2008), triggering an alert regarding its conservation status. But due to the species' small size and difficult diagnosis, more specimens in major zoological collections could be misidentified, highlighting the importance of a broad analysis of the material available in museums.

Acknowledgments

I am grateful to Daniel Klingberg Johansson for the date and photos of the specimen NHMD R4448, essential for carrying out this work; to an anonymous reviewer and the editor Claudia Koch for suggestions; to Evan Gans and Gans Collections and Charitable Fund Trustees for making available to me a copy of the raw data of Carl Gans' 1966 work, which is deposited in the U.S. Library of Congress. This study was originally conceived when I was a postdoctoral researcher at the Universidade Federal de Viçosa, funded by the Programa Nacional de Pós-Doutorado CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior), between 2018 and 2019, and by a visiting scholarship from the Field Museum (USA) in 2019.

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